

The Applicants' Invention

The present invention relates to the application of a protective layer upon a surface of a printed circuit board. Specifically, the printed circuit board includes runs or traces formed of copper upon which are formed a protective silver layer. The silver layer is formed on the copper traces using a displacement immersion silver-plating process. Such displacement plating processes differ from electrolysis processes because the silver coating forms on the surface of the copper by means of a simple displacement reaction which results from the relative electrode potentials between the copper and the silver. Thus, the oxidizable copper present on the surface of the printed circuit board is protected by thin overlayer of silver which prevents copper oxidation.

The present application overcomes several problems known in the prior art for providing silver protective coatings. These include the elimination of ammonia, cyanide ions and other undesirable process chemicals, as well as the ability to provide a silver coating with good adhesion and solderability.

In a broad sense, the present application relates to a process for forming a silver coating upon the surface of a metal having an electropositivity that is less than the electropositivity of the silver. For simplicity in this description, the metal having electropositivity less than that of silver will be described as copper, however it is to be understood that the invention is not intended to be limited as such, and rather, copper is substituted simply for semantic purposes. Thus, in the process, the surface of the copper is coated with an aqueous composition which includes silver ions and a complexing agent that is a multidentate ligand. The aqueous composition has a pH in the range of about 2 to about 12 and is specified as being free of ingredients selected from the group consisting of ammonium ions, thiosulphate ions, and combinations thereof. When a printed circuit board having copper traces thereon is subjected to the claimed process, the result is a printed circuit board having copper traces upon which are deposited a thin layer of silver. Of course, as noted above, the invention as claimed is not intended to be limited strictly to printed circuit boards having copper traces, but rather to those circuit boards having traces formed of any metal having an electropositivity that is less than the electropositivity of silver.

Rejection of Claims 1, 3-7, 10-16, 21-26 and 34-43

Claims 1, 3-7, 10-16, 21-26 and 34-43 have been rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 3,993,845 to Greenberg, et al., (hereafter Greenberg '845) in view of U.S. Patent No. 5,322,553 to Mandich, et al., (hereafter Mandich '553).

In particular, the Action notes that Greenberg '845 teaches novel copper-silver metallic films prepared on transparent articles by chemical replacement of silver for copper. The references are said to describe a transparent article that has been coated with copper by conventional deposition methods and then contacting the article with a solution including a silver salt, ammonia and a complexing agent which promotes replacement but which does not accelerate the oxidation of residual metallic copper in the film. The Action notes that Greenberg '845 teaches a silver plating solution which is free of ammonium ions or thiosulphate ions. The Action also notes that Mandich '553 teaches electroless plating compositions which do not contain ammonia, formaldehyde, cyanide, etc. Rather, the Action notes that Mandich '553 teaches that formaldehyde does not make the plating bath stable or commercially usable on a large scale and that the use of ammonia either as a stabilizer, a complexing agent, or both is known to be very shock sensitive. Thus, the Action concludes that it would have been obvious for one skilled in the art at the time the invention was made to have modified the silver plating solution of Greenberg '845 by making the plating solution free of ammonia as suggested by Mandich '553, because one skilled in the art would want to avoid the problems associated with the uses evidenced above.

The Applicants have previously argued that Greenberg '845 fails to teach a displacement process without the use of additional additives such as ammonia or thiosulphate ions, and the Examiner has agreed with these comments. However, the Examiner has maintained the rejection

of the subject claims over the combination of Greenberg '845 and Mandich '553 on the basis that one cannot show non-obviousness by attacking references individually where the rejection is based upon a combination of the references.

In overcoming a rejection based a combination of references, it is proper to show, among other things, that (a) there would have been no suggestion in the art to combine the references, (b) the references cannot properly be combined, and/or (c) even if the references are combined, the combination would not suggest the invention claimed by the Applicant.

In the present case, the Applicants take the position that the cited references cannot properly be combined. Specifically, Greenberg '845 relates to a method for preparing a copper-silver metallic film on a transparent surface by providing that surface with a copper layer and then contacting the copper-coated surface with a solution comprising a silver salt, ammonia and a complexing agent. Greenberg '845 explicitly states, "thiosulphate complexing agents are not employed since thiosuphate has been found to accelerate the subsequent oxidation of residual copper in the film, ..." (Column 3, Lines 14-17). In contrast, Mandich '553 describes an electroless silver plating solution having a silver complex, a thiosulphate salt and a sulfite salt.

At the outset, the Applicants note that since Greenberg '845 states that thiosulphate complexing agents are not employed, whereas Mandich '553 explicitly requires the use of thiosulphates, the references explicitly teach away from one another. In particular, if a reference explicitly states that a particular chemical species would not be used, that reference would teach away from a second reference which requires use of that same species. Thus, rather than containing a suggestion that the references should be combined, these references explicitly teach away from any such combination.

Likewise, it is unclear how the references could properly be combined since Greenberg '845 teaches away from the use of a thiosulphate, whereas Mandich '553 requires the use of a thiosulfate. Additionally, whereas Greenberg '845 explicitly requires the use of ammonia or an ammoniacal silver salt, Mandich '553 explicitly states, "The bath does not contain ammonia or cyanide ions as a plating constituent, and has a plating rate and a plating solution stability far greater than previously known electroless silver baths." (Column 1, Lines 50-54). Since each of Greenberg '845 and Mandich '553 includes a chemical species that is explicitly excluded from the other reference, the references cannot be properly combined. If the references were to be theoretically combined, the result would be an impossibility, i.e. a material which simultaneously does not employ a thiosulphate and does employ a thiosulphate, and which simultaneously does not employ an ammonia species and does employ an ammonia species. Since such a compound clearly cannot exist, any combination of the references will be improper.

Finally, the Action notes that the Applicants' claims require a "composition that is either free of ammonia ions, thiosulphate ions or a combination thereof." (Office Action, page 6). The Action further notes that Mandich '553 teaches a composition that is free of ammonia and thereby concludes that the claim limitation is met. The Applicants believe that this conclusion is based upon an improper reading of the claim language. Claim 1 specifically requires that the aqueous composition "is free of ingredients selected from the group consisting of ammonium ions, thiosulphate ions and combinations thereof." Thus, the claim does not set forth ammonium ions and thiosulphate ions in the alternative, but rather, calls for a composition that contains neither ammonium ions, nor thiosulphate ions, nor a combination of ammonium and thiosulphate ions. Since any combination of Greenberg '845 with Mandich '553 would necessarily require a

composition having at least one of ammonium ions or thiosulphate ions, such a combination would not have suggested the subject matter of Applicants' claim 1 and its dependants.

In view of the above, withdrawal of the rejection of claims 1, 3-7, 10-16, 21-26, 34-43 on these grounds is respectfully solicited.

Rejection of Claims 2, 17, 18 and 44

Claims 2, 17, 18 and 44 have been rejected under U.S.C. § 103 as being unpatentable over Greenberg '845 in view of Mandich '553 and further in view of the Applicants' admitted state of the art as laid out in the specification at Page 1, Line 8 to Page 9, Lines 26. The Action further notes that features described above in rejecting claims 1, 3-7, 10-16, 21-26, 34-43 over Greenberg '845 in view of Mandich '553 have been incorporated. In particular, the Action notes that the combination of Greenberg '845 and Mandich '553 would have failed to teach silver plated metal conductive pads, through-holes and combinations thereof with the aid of masks for covering the areas desired to remain free of silver coating. That notwithstanding, the Applicants' admitted state of the art is said to teach that it is well known to utilize silver coating on copper substrates for protecting the copper from oxidation with the use of masks. Thus, the Action concludes that it would have been obvious to combine Greenberg '845 and Mandich '553 to produce a silver replacement process for depositing silver on copper conductive pads and through-holes.

As noted above, Greenberg '845 and Mandich '553 cannot be properly combined because, whereas Greenberg '845 requires a plating solution that is free of a thiosulphate, Mandich '553 explicitly requires the use of such thiosulphate. Likewise, whereas Mandich '553 requires a plating solution that is free of ammonia species, Greenberg '845 explicitly requires the

use of ammonia. Thus, a combination of Greenberg '845 and Mandich '553 with the Applicants' admitted state of the art, still would not result in a silver plating process of the type claimed by the Applicants. Accordingly, withdrawal of the rejection on these grounds is respectfully solicited.

Rejection of Claims 8, 9 and 20

Claims 8, 9 and 20 have been rejected under 35 U.S.C. § 103 as being unpatentable over Greenberg '845 in view of Mandich '553 and further in view of U.S. Patent No. 4,067,784 to Leahy, et. al. (hereafter "Leahy '784"). The Action applies Greenberg '845 and Mandich '553 as described above and then cites Leahy '784 as teaching a non-cyanide acidic silver plating bath which incorporates a buffer and a surfactant. Additionally, the Action notes that the plating solution of Leahy '784 can contain brighteners and other additives known to those skilled in the art. Thus the application concludes that it would have been obvious for one skilled in the art at the time the invention was made to have modified the combination of Greenberg '845 and Mandich '553 to provide a silver plating solution incorporating additives such as buffers, surfactants and brighteners.

The Applicants believe that the rejection of claims 8, 9 and 20 on these grounds is improper for the same reasons given with respect to rejections discussed above. In particular, Greenberg '845 requires the use of a silver plating solution that contains an ammoniacal silver salt and lacks a thiosulphate complexing agent, while Mandich '553 describes a silver plating solution that contains a thiosulphate salt yet does not contain ammonia. Thus, it is the Applicants' position that there is no suggestion that the references should be combined, and that any such combination of Greenberg '845 with Mandich '553 to produce the claimed silver

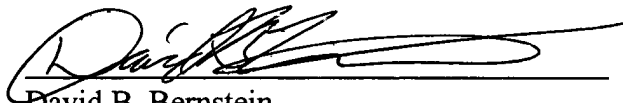
plating solution free of both ammonia and thiosulphate would be impossible. The Applicants maintain the position that the combination is improper in the context of pending claims 8, 9 and 29 as well. Accordingly, withdrawal for rejection on these grounds is respectfully solicited.

Conclusion

In view of the Applicants' remarks above, each of pending claims 1-18, 20-26 and 34-44 is believed to be in a condition for allowance. Reconsideration, withdrawal of the rejections, and passage of the case to issue is respectfully requested.

If upon receipt and consideration of this response, it is the Examiner's position that the case is not yet ready to pass to issue, it is respectfully requested that the Examiner contact the Applicants' undersigned attorney for the purpose of arranging an interview to expedite the prosecution.

Respectfully submitted,



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